



## Apply Functional Modeling to Consequence Analysis in Supervision Systems

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# APPLY FUNCTIONAL MODELING TO CONSEQUENCE ANALYSIS IN SUPERVISION SYSTEMS

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OECD Halden Reactor Project

# AGENDA

- Introduction
- Consequence analysis and functional modeling
- Multilevel Flow Modeling (MFM)
- Rule-based tool development
- Implementation challenges
- Conclusion

# INTRODUCTION

- PHD project
  - Funded together by DTU and IFE
- Period
  - March 2012 to March 2015
- Subject
  - Consequence Reasoning in MFM and Its Application in Operation Supportive Systems

# CONSEQUENCE ANALYSIS



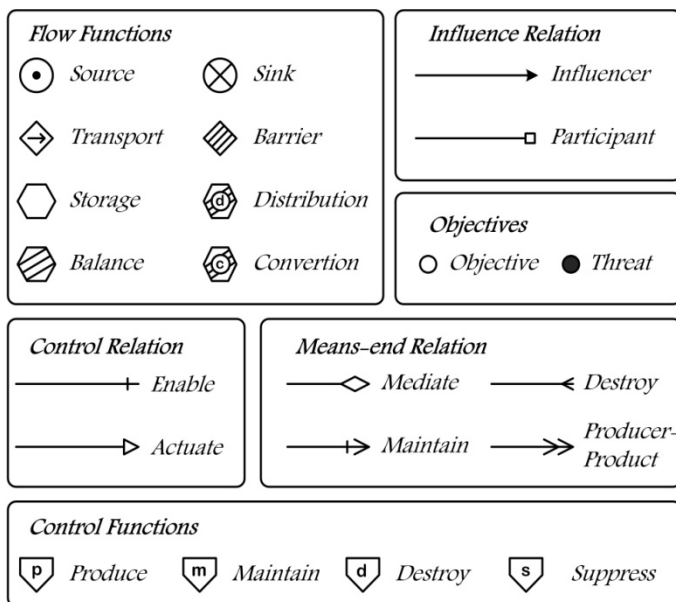
- Scope:

# FUNCTIONAL MODELLING

- What – Definition
- Why – Justification
  - Means-end concept
  - Goal-function representation of the process
- How – Methodology

# MULTILEVEL FLOW MODELING

- MFM Concepts and MFM models



- Means-end and whole-part decomposition
- State dependency relations are generic
- Means-end relations
- Means-end patterns
- MFM patterns
- Potential path of event propagation, temporal information

- Domain: NPP, etc. [refs]

# MFM REASONING



# RULE-BASED SYSTEM

- Components of a typical rule-base system:
  - A user interface or other connection to the outside world through which the knowledge of the system is collected and the input and output signal can be sent.
  - A knowledge base that stores the system information and conditions.
  - A rule base contains a set of rules, which is a specific type of knowledge base.
  - An inference engine or semantic reasoner, which infers information or takes action based on the interaction of knowledge base and the rule base.

# RULE-BASED SYSTEM

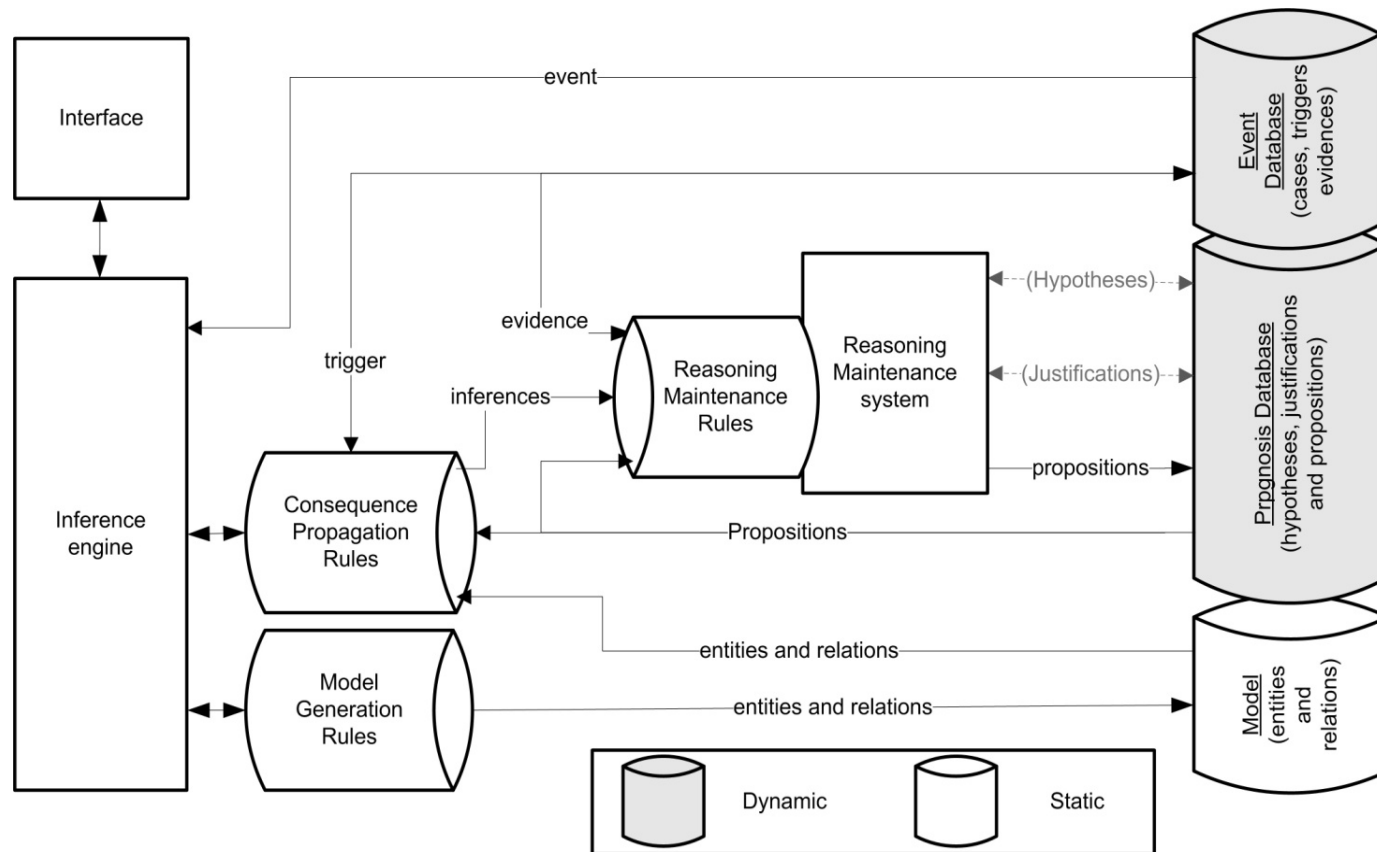


Fig2. Reasoning System Architecture for Consequence Analysis

# RULE-BASED SYSTEM

- Database:

Modelling methodology challenge

- Static – Functional Model (process knowledge)
- Dynamic – Observations and Inferences

- Rule-base:

Interpretation/Visualization challenge

- Reasoning rules

- Special Facility:

Reasoning strategy challenge

- Reasoning Maintenance System (RMS)

- Interface:

- Model Editor, Case Editor, etc.

Integration structure challenge

# CHALLENGES

- Modelling challenge:
  - Represent operation modes, barriers, control structures, etc.
  - [Refs]
- Reasoning strategy challenge
  - Inference propagation and validation
- Integration challenge
  - Interface design with other operation support systems
- Data interpretation challenge
  - Structure-role-function mapping
- Visualization challenge
  - Knowledge representation and display

# INFERENCE PROPAGATION



- Identify propagation loops

# MULTIAGETN ARCHITECTURE



# CONCLUSION

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**THANK YOU FOR YOUR ATTENTION!**